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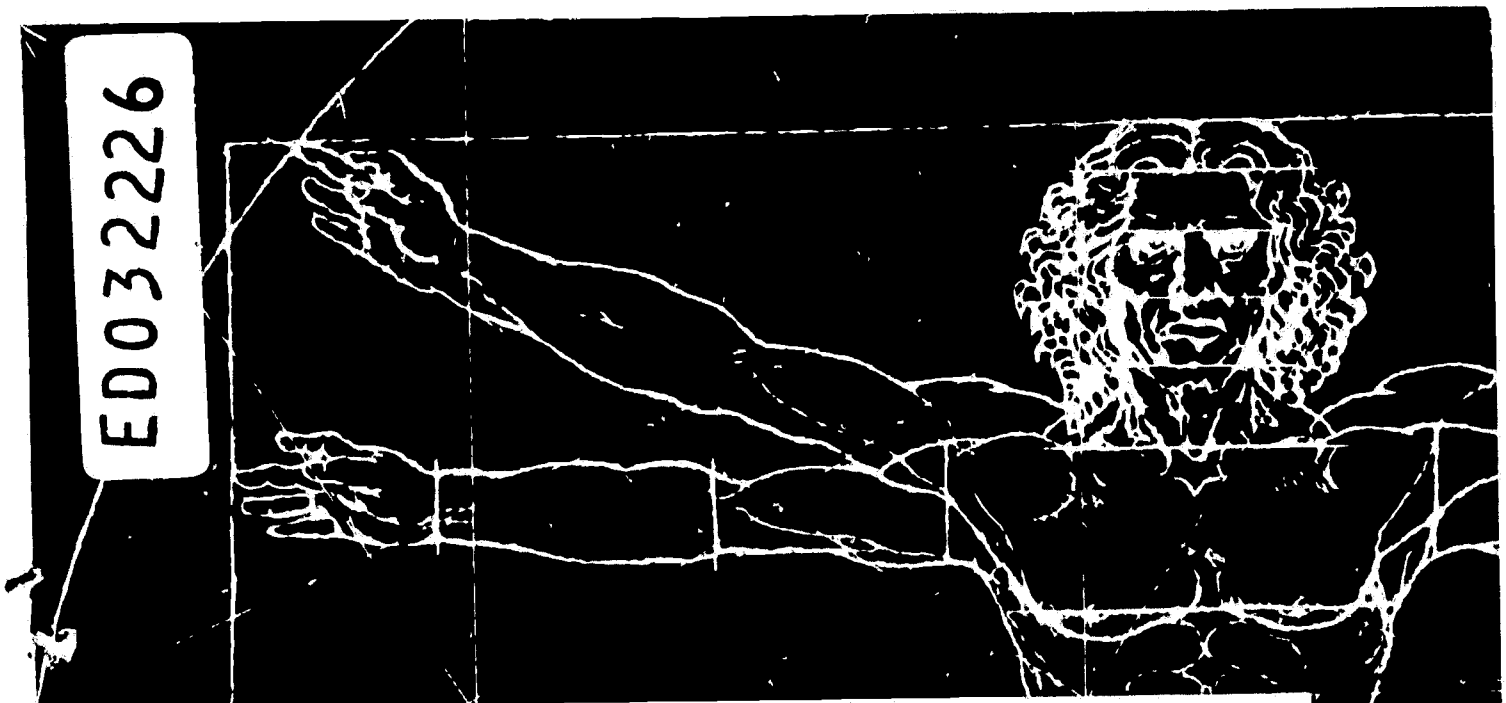
The first dozen years of the National Science Foundation's (NSF) Summer Institutes Program, 1954-65 are reviewed. The full report entitled "An Investment in Knowledge" is scheduled for publication in 1969. The forerunner of NSF Summer Institutes was held during July and August of 1954 at the University of Washington. Fifty-three high school teachers from 22 states attended the four week session to study mathematics. The initial success of this program led to a greater investment by NSF in institutes to train science and mathematics teachers in public and private schools and at all academic levels, kindergarten through college. The total NSF outlay for institutes through 1965 was close to 300 million dollars. In 1965, 43 million dollars financed 449 institutes with approximately 21,000 high school teachers as participants. The report is replete with specific important events in the development of the Institute program and contains accounts of numerous conversations with NSF officials and congressional committeemen. (BC)



TO IMPROVE SECONDARY SCHOOL SCIENCE AND MATHEMATICS TEACHING

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TO IMPROVE SECONDARY SCHOOL SCIENCE AND MATHEMATICS TEACHING

(A Short History of the First Dozen Years of the National Science Foundation's Summer Institutes Program, 1954–1965)

By Hillier Krieghbaum and Hugh Rawson

A summary study of the National Science Foundation's programs for improving secondary school teaching of science and mathematics through summer training, based on a full-length report written by Hillier Krieghbaum, Professor of Journalism, and Hugh Rawson, Associate Research Scientist, both of New York University, and submitted to NSF in June 1965, in compliance with a contract between the Foundation and the University. The full report, "An Investment in Knowledge," is scheduled for publication by the New York University Press during 1969.

On July 26, 1954, a group of 53 high school teachers began attending summer classes at the University of Washington. They had come from 22 States to study mathematics for the next 4 weeks and, to the average observer, undoubtedly appeared much like any other group of summer session students.

Closer inspection would have revealed some significant differences. The classes the teachers attended for 4 hours each day were not listed in the university's regular catalog but had been designed especially for this occasion. And in contrast to the courses typically taken by high school teachers who returned to college for summertime study, these emphasized the subject matter of mathematics rather than teaching methods. "Algebra and Number Theory" and "Logic and Geometry" were topics of the two main series of lectures.

This particular group also was more coordinated than the usual group of summer school students. Two-thirds of these high school teachers lived in Austin Hall, a small dormitory set aside exclusively for them. The teachers also had a dining room to themselves, went on two class field trips, had several organized tours and sightseeing excursions, and gathered together every afternoon for coffee and free-wheeling discussions of the ways in which mathematics was taught in high schools around the country.

The session apparently was a success. In his report on it, Dr. Carl B. Allendoerfer, University of Washington professor in charge, said:

> "The greatest gain came from an awakening of the teachers to mathematics as a living subject. This view is best summarized in the words of one of the teachers: 'If you meant to inspire a group of teachers with a desire to definitely try to improve the high school program, I think you have succeeded. I had thought I had reached a stagnation point, but I think now that I am not too old to accomplish a great deal more!' "

This 4-week program represented a major innovation in American education. The National Science Foundation, an agency of the Federal Government, had awarded the University of Washington a $10,000 grant to pay the costs of conducting the special courses and to provide stipends of $200 to defray the room, board, and travel expenses of 27 of the teachers. The attendance of 26 other teachers, who came even though they had to pay their own way, was a tribute to an idea that Dr. James B. Conant was to describe 9 years later in his book, "The Education of American Teachers," as (and the italic

is his) *"perhaps the single most important improvement in recent years in the training of secondary school teachers."*

These 53 teachers were in the vanguard of what has become a massive investment by NSF in institutes to train science and mathematics teachers in public and private schools and at all academic levels, from kindergarten through college. The total outlay for institutes through 1965 was close to $300 million. Spending that year amounted to about $43 million, most of it—nearly $37 million—on institutes for teachers at the secondary school level (grades 7 to 12 or, for most communities, junior and senior high school).

The University of Washington session was a forerunner of what NSF now calls a summer institute. The major difference in format between it and the present model is one of length; most summer institutes now run 6 to 8 weeks. NSF financed 449 such institutes for 1965, with approximately 21,000 high school teachers as participants. And these were only part of the Foundation's total effort in teacher education. The institute idea has been adapted into other forms and NSF also supports: (1) Academic year institutes, which provide from 9 to 12 months of full-time training during the regular school year; (2) in-service institutes, in which teachers commute to classes on Saturdays or in the evenings during the academic year; and (3) conferences, which are similar to, but shorter than, summer institutes.

To Understand How and Why These Programs Evolved, it is necessary to go back to May 10, 1950, when President Harry S. Truman signed into law the bill that created the National Science Foundation. The new agency was charged with a number of missions, some of a very specific nature such as "to initiate and support basic scientific research" and "to award . . . graduate fellowships" in the "mathematical, physical, medical, biological, engineering, and other sciences." More generally, NSF also was directed "to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences."

When the Foundation began operations in early 1951, its first Director, Dr. Alan T. Waterman, and the 24 members of its governing body, the National Science Board, concentrated initially on setting up programs in the areas cited specifically in the Foundation's enabling legislation. The first mention of what was to evolve into the NSF institutes did not occur until a meeting of

the Board on July 27–28, 1951. Lifting a phrase from the NSF act, the staff proposed that $250,000 be spent in fiscal year 1953 on a new program called research education in the sciences.

Plans for the RES program were worked out by Dr. Harry C. Kelly, then head of the Foundation's Division of Scientific Personnel and Education, who wrote a staff paper that described its philosophy in the following manner:

> "The strength and effectiveness of our future science depends in large measure on the quality of the scientists and engineers turned out by our educational institutions. The National Science Foundation naturally is not interested solely in increasing the numbers of people having adavnced degrees in science, but rather in raising the total scientific potential of our country. Efforts therefore are to be made to improve the quality of teaching of the sciences by giving an opportunity to the teachers of science to keep abreast of their particular scientific field and by encouraging them to participate in research projects."

The program was aimed at college teachers, primarily those in the smaller, liberal arts colleges who were not in the mainstream of scientific research. Kelly suggested that RES might involve such activities as providing financial aid to permit these teachers to spend their summers at research centers or special seminars. If the program were to become "effective," he predicted that 10 times the proposed $250,000 would be needed.

During the remainder of 1951 and the first 6 months of 1952, NSF received a varied assortment of about 25 requests from individuals, corporations, colleges, and universities for support of projects in the general area of research education in the sciences. The new agency, however, was operating on the proverbial shoestring. It received appropriations of $3,500,000 for fiscal year 1952 and $4,750,000 for fiscal year 1953. As a result, the proposed expenditures for RES were cut drastically and only one of this initial group of proposals received support. This was a grant of $7,200 to Woods Hole Oceanographic Institution in Massachusetts to provide summer fellowships there for junior instructors and graduate students. But the other proposals, while they were not supported, gave NSF staff members a "grassroots" feel of the needs and desires of the academic community and provided ideas from which programs and policies were to evolve.

Undoubtedly the most significant, in the long run, of the denied proposals was one submitted by Dr. J. W. Buchta of the University of Minnesota. Unlike most of the early requests, which were for support of college-level projects, this proposal asked NSF to finance a

training program for high school physics teachers. The concepts and plan of operation that Buchta outlined were remarkably close to contemporary summer institutes.

As was true of a number of the pioneer institute proposals submitted to NSF, the initiative in this case came from the Foundation staff rather than the requesting institution. Kelly had read an announcement in the September 1951 issue of Higher Education about a new training program at the University of Minnesota for college teachers who had received Ford fellowships. Casting out lines for more ideas for RES, Kelly wrote to Minnesota to learn details of the program there and was put in touch with Buchta, then chairman of the physics department and assistant dean of the college of science, literature, and the arts. The two men met that November when Buchta, on a trip east, arranged to see Kelly in Washington.

They spent most of a Sunday afternoon discussing the types of programs that NSF might support in science education and Buchta, after he had returned to Minneapolis, wrote Kelly a four-page, single-spaced letter which developed in detail some of the ideas they had considered. Of these, Buchta was interested most in a plan for holding a summer institute for high school physics teachers. Describing the need for such a program, he said:

> "When the high school science teacher returns to college during a summer session, he often finds he is excluded from the graduate courses in science because he does not have the stated prerequisites. As a result, we find many of the more able and ambitious teachers—those who return for additional college work—are diverted to professional courses and degrees in education—often administrative phases. There is need for summer programs explicitly designed for the high school science teacher. For many young people, the time of decisions regarding their careers is in the high school period. The high school teacher is an important factor in the education of future scientists. . . .
>
> "An institute of six weeks duration, attended by thirty to fifty teachers would seem to be indicated. A program designed for the teachers—refresher courses, on basic concepts—courses on contemporary physics and on the role of science in our society would be in order for teachers of physics. Different programs could be designed for teachers of the other sciences. Field trips, visits to industrial plants, could be included. Arrangements should be made for housing the teachers in one group. They would, for the six weeks, be concentrating during usual working hours and after, on topics under consideration."

Buchta estimated such a project would cost from $12,000 to $15,000, including "scholarships" for participants, and concluded by telling Kelly that the University of Minnesota would like to serve as a "guinea pig" for this phase of NSF's activities by holding an institute in the summer of 1952.

In a return letter to Buchta, Kelly voiced some doubts about whether NSF would support such a proposal. He explained that internal discussions of a possible NSF scholarship program had "indicated that the Board would like to put greatest emphasis on graduate training and research and, therefore, would hesitate to give too great encouragement to the approval of the project for advanced training for high school teachers." Nevertheless, Kelly asked Buchta to submit a formal request, telling him, "If you are agreeable, however, I should like to see how far we can go with the proposals." Buchta did this on December 14, 1951.

A formal staff recommendation approving Buchta's proposal was prepared. But, after discussing the proposal informally with several members of the National Science Board, Kelly telephoned Buchta in February to report that a grant would not be made. This decision apparently involved several factors, including the belief by the Board that the basic research and graduate fellowships programs should receive top priority in dividing up the relatively limited funds available. Some Board members also seemed to feel that support of programs at the high school level might somehow—as one later said—"demean" NSF. In addition, as a new and small agency, the Foundation was hesitant about edging into what the schools of education regarded as their bailiwick.

Kelly, recalling more than a decade later the reasons for turning down the first institute proposal, said that the enthusiasm of several Board members, who initially favored it, cooled after sounding out education professors in their institutions on the merits of the project. He explained:

> "Up until only a few years ago, the Board was reluctant about getting into educational programs. And the 'educator' in turn, looked at the Foundation with apprehension, asking what we knew about this whole problem."

The decision made in this instance shortly was ratified as official policy. After discussing the question of possible support for secondary school programs at its first meeting on March 6–7, 1952, the Divisional Committee for Scientific Personnel and Education (a group of leading scientists and educators appointed by the National Science Board to advise the SPE Division director) formally resolved that "the Foundation should not enter the field of secondary education at this time, but that the idea should be tabled for further consideration."

With programs for high school teachers thus held in abeyance, Kelly pursued the institute concept at the college level. He mentioned the possibility of NSF supporting such a project at a meeting in July 1952 with Dr. G. Baley Price of the University of Kansas. As chairman of the Committee on Regional Development of Mathematics, a five-man group appointed earlier that year by the chairman of the National Research Council's Division of Mathematics to study the effects of various governmental programs on the mathematics departments of the smaller graduate schools, Price was in an excellent position to explore the idea in greater detail.

When he broached Kelly's plan to the members of his committee at a meeting that September, they agreed unanimously that—in Price's words—a "summer institute of the kind outlined by Dr. Kelly" should be held in 1953. This initial enthusiasm was to be sustained, with members of the regional committee assisting NSF in planning and organizing institutes up until 1955 when the Mathematical Association of America, recognizing that this had become a full-time assignment, appointed what was described at the time as a special "committee to help Harry Kelly."

The regional committee at its September meeting worked out a skeleton budget for an institute and recommended that NSF seek a proposal for 1953 from one of a list of five universities. While covering mechanical aspects of the proposed project, the committee's suggestions were vague on the subject of institute content. This prompted one of the committee members, Dr. William S. Duren, Jr., of Tulane University, who was serving then as acting program director for mathematics in NSF's Division of Mathematical, Physical, and Engineering Sciences, to send Kelly a memorandum discussing possible courses, lecturers, and general institute format. Duren wrote:

> "Here is the way I would want to run a Summer Mathematics Teachers Institute if I were doing it. Everybody would take three courses, each one hour a day, five or six days a week, for six weeks, plus a discussion period of one hour a day in the afternoon followed by a coffee hour. I would want a good college library handy. Also we would need a loafing room and/or coffee shop equipped with blackboards. . . .
>
> "The work of the six-week Institute would consist of a solid mathematical program with little formal discussion of educational problems in mathematics. It would be important to give the members some work to do every day and not merely expose them to a flow of experts' words, however erudite. Also it would be important to pitch some of every day's work at a low technical level where members would be sure to feel comfortable."

To get some outside opinion of the institute idea, Duren and Kelly sent copies of the letter from Price containing the regional committee's suggestions to Dr. Saunders MacLane, professor at the University of Chicago and at that time president of the Mathematical Association of America. MacLane and the six MAA members whom he asked to evaluate the plan definitely favored it, but stated even more strongly than had Duren the desirability of emphasizing the subject matter of modern mathematics and its impact on the curriculum. MacLane, for example, declared:

> "The summer institute program should not be primarily concerned with pleasant platitudes on pedigese, tricky devices for teaching trigonometry, or jaunty introductions to general education background, though, of course, some treatment of general education courses is in order."

The stress of the MAA members on subject-matter training reflected in part the wide split that had developed between "scientists" (and it should be remembered that most NSF officials had been trained as scientists and considered themselves in that camp) and "educators." Illustrating vividly the width of this split was the following comment by one MAA reviewer on the qualifications of a professor who had been suggested by the regional committee as a potential director for the institute:

> "[He] is very valuable and enthusiastic member of the Mathematical Association whose talents should quite properly be used in appropriate ways. I note that . . . he is half-time in Mathematics and half-time in the Education Department. It is well known that professional mathematicians have a deep suspicion of professional Educators. For this reason it would be virtually impossible for [him] to assemble a proper staff."

As a result of the MAA evaluation and continuing correspondence between Price and Kelly, two proposals for summer institutes in mathematics for college teachers were submitted to NSF: One by Price for the University of Kansas and the other by a regional committee member, Dr. Burton W. Jones, for the University of Colorado. Since the RES budget for 1953 was still small, Kelly did not feel NSF could support two institutes in the same subject. Therefore, he asked the regional committee at a meeting in Washington on November 20, 1952, which of the two it recommended.

The committee voted unanimously for Colorado, with a major factor in the decision apparently being the more favorable climate of that State. It was hoped this would provide an extra incentive for teachers to attend. NSF accepted the committee's choice, the National Science Board approving a grant of $12,750 for the project on January 30, 1953.

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The institute (Jones actually called it a conference) ran for 8 weeks and was attended by 81 teachers; 21 of whom received stipends of $300 while the remainder paid their own expenses. The program was typical of most early NSF institutes in that it was conducted on a more sophisticated academic level than comparable institutes in the 1960's. And it had an "all-star" cast of lecturers, including Dr. Emil Artin, Princeton University, and Dr. R. E. Wilder, University of Michigan, who gave the main lectures on "Modern Developments in Algebra" and "Foundations of Analysis and Geometry," respectively. Shorter series of talks were delivered by Dr. George Polya, Stanford University; Dr. Eugene P. Northrop, University of Chicago; and Dr. Carroll V. Newsom, associate commissioner of education of the State of New York.

In other respects, the institute was quite like later ones. Most participants lived in a single dormitory; special arrangements were made for them to eat as a group; and discussion sessions on curricular topics were organized. Even the problems encountered were much the same as those still met in the 1960's. For example, according to Jones' report on the institute, the wide variation in background and training of the participants led to the suggestion that in future institutes it might be helpful to have someone "perhaps the lecturer's assistant," conduct elementary sessions for those who needed help. Because Jones covered such points as this in detail, Kelly later distributed copies of this report, making the Colorado institute a model on which subsequent ones were patterned.

NSF also supported a second institute during the summer of 1953. It was run at the University of Minnesota by Buchta who, following his unsuccessful proposal for an institute for high school teachers in 1952, had come back in the fall of that year with proposals for two institutes in physics—one for college teachers and one for high school teachers—which he wanted to hold concurrently in 1953. Submitting the two proposals, he told Kelly:

> "The high school group would profit by the presence of the other group. On the other hand, I believe it would be very healthy to have the college group become acquainted with the high school teachers and their problems. It is my opinion that in order to increase the pool of talent dedicated to the sciences, we must turn to the secondary schools."

NSF awarded Minnesota a grant of $9,500 for a 5-week institute for 21 teachers of college physics but, taking the same line as it had previously, decided not to support the high school part of Buchta's proposed program. After the high school project was turned down by NSF, Buchta took the proposal to the Fund for the Advancement

of Education, an affiliate of the Ford Foundation. Writing to Dr. Alvin C. Eurich at the fund, Buchta presented his case in these terms:

> "Never before except possibly during World War II have we experienced the present demand for qualified graduates in the technical areas, especially in physics. This . . . points up a situation which I have long deplored. I refer to the teaching of science in the secondary schools and the fact that, although college and university teachers complain about the lack of preparation and enthusiasm of the high school teacher for his job, we in the university science departments have done very little that is constructive in improving the situation."

Buchta made his point well enough to receive a grant from the fund for what proved to be the first of four (three were held in 1954) FAE-supported institutes for high school teachers that were run in conjunction with NSF-supported institutes for college teachers. These combined sessions enabled NSF, without putting up any money of its own, to learn about the training problems of high school teachers and the methods of organizing institutes at that academic level.

The first of the FAE-supported institutes was attended by 34 teachers, most of them from Minnesota. The program, which included daily lectures, discussions, and demonstrations, dealt with the basic concepts of physics as well as "Modern Physics." Evaluating the institute in a report to the fund, a copy of which also went to NSF, Buchta said:

> "The response and enthusiasm of the group was satisfactory. The discussion leaders and lecturers were sometimes startled by the lack of knowledge of some of the teachers, but this fact emphasized the need for such a program. A common statement by the high school teachers was, 'This is just what we need!' "

THE FAE INSTITUTES FOR HIGH SCHOOL TEACHERS were by no means the only example of this type of training program available for study by NSF. Buchta's thinking, for instance, had been influenced strongly by a series of institutes begun in 1945 by General Electric Co. First held for high school teachers of physics on the campus of Union College, Schenectady, N.Y., the GE program had become a multi-campus operation by 1953 with institutes for science teachers at Union and Case Institute of Technology in Cleveland and institutes for mathematics teachers at Rensselaer Polytechnic Institute, Troy, N.Y., and Purdue University, Lafayette, Ind.

While fairly heavily laced with the contributions of American industry to the advancement of science and technology, the GE institutes anticipated in many ways those later developed by NSF. The brochure for the initial session at Union, for example, could be used with only minor changes to publicize an NSF institute in the 1960's. On the topic of subject matter vs. teaching techniques, it said:

> "The program of study has been designed, not immediately to influence pedagogical methods, but to enlarge each Fellow's grasp of recent developments in physical science. When he returns to his classroom at the end of the summer, freshly aware of the directions which the scientific adventure into the unknown is taking, he will undoubtedly inform his teaching of fundamental principles with new understanding and a spirit more likely to stir scientific ambition in the minds of his students."

Similar institutes for high school science and mathematics teachers were supported during the 1940's and 1950's by other firms and organizations, including Westinghouse Educational Foundation, E. I. du Pont de Nemours & Co., Shell Companies Foundation, and Crown Zellerbach Foundation. Some colleges and universities also offered tailormade courses for high school teachers as part of their regular summer sessions and, in a few instances, sponsored institute-type programs. An early example in the latter category was a series of mathematics institutes held annually from 1941 to 1952 by Dr. W. W. Rankin at Duke University.

With such precedents before them, NSF staff members continued to consider the possibility of establishing a program for the secondary school teachers. The Foundation's ultimate aim was to meet the Nation's need for more scientists and engineers. This need was not the result of a shortage of bright boys and girls in the United States but rather of the failure of many of the brighter ones to go to college. NSF estimated in 1953, for example, that "over two-thirds of our high school graduates, having at least the intelligence of college graduates, do not enter college." Viewed in this light, it was apparent that programs striking further back in the educational cycle might have larger, although less immediate, rewards than, say, fellowships for graduate students.

And the high school teacher appeared to be the key. While other factors such as family income and whether their parents had attended college were involved, it was difficult to see how more students could be inspired to go to college—and specifically, to study science and mathematics—if they were instructed in high school by people who themselves did not understand, or have enthusiasm for, the subjects they taught. NSF officials found much evidence indicating that this was too frequently the case—especially in science and

mathematics, where the disparities between teachers' pay and salaries in business and industry appeared greatest. Often the teacher trained in physical education doubled as the physics teacher and the teacher trained in biology had to conduct classes in chemistry and physics, too.

Dr. Bowen C. Dees, then head of the fellowships program and Kelly's right-hand assistant, pointed out years later:

> "Even when you were working on fellowship business, if you talked to a professor for more than 30 minutes or so, the topic of the miserable state of teaching in the high schools would open up."

As an example of the generally poor standard of science teaching in the high schools in the early 1950's, Kelly reported in an interview after leaving NSF that some college chemists then argued that they would rather have students who had never taken high school chemistry at all than ones who had taken the courses they did. Kelly continued:

> "The staff zeroed in on the high school problem at a very early stage in the game. Our job was to improve the scientific competence of the Nation, and it was obvious that you don't do this with programs that affect only the graduate level. . . . We knew that the teacher was the key. Fellowships were the first obvious answer. But fellowships were not applicable to the particular problems of the high school teacher because few colleges offered courses especially designed for high school teachers as part of their regular curricula.
>
> "After much discussion among the staff and members of the Board and Divisional Committee for Scientific Personnel and Education, we finally concluded that we should establish some mechanism: (1) to help teachers, and (2) to encourage universities to set up special courses. This mechanism was the institutes."

This, then, was the line of thinking that led NSF in 1954 to support its first institute for high school teachers—the session in mathematics at the University of Washington, described at the beginning of this report. NSF also financed three other institutes for college teachers that year: two in mathematics and one in chemistry.

In setting up the 1954 program, NSF again received much assistance from other organizations. The chemistry institute at the University of Wyoming, for example, represented an expansion of a workshop that a committee of the American Chemical Society's Division of Chemical Education had planned to sponsor at that institution. The chemistry group had held workshops for college teachers since 1950, thus providing NSF with a backlog of experience in this

type of operation as well as a manpower source. Five of the men who were active in the workshops program later served on the NSF institutes staff, including Dr. William E. Morrell, who directed the Wyoming institute and who became NSF program director for summer institutes in 1959.

The Committee on Regional Development of Mathematics also continued to play an important role. It gave advice and support in organizing institutes in mathematics for college teachers at the University of Oregon and at the University of North Carolina, as well as the institute for high school teachers at the University of Washington.

In Selecting Institutes for the Summer of 1954 NSF for the first time encountered a problem that for at least the next decade was to remain potentially the most explosive of any it faced—segregation in the South.

Duren, working through the regional committee, was anxious to find a place in the South to hold an institute and he spent part of his vacation during the summer of 1953 with another professor visiting colleges, resorts, and summer camps in the North Carolina-Tennessee area. Writing to Price, the committee chairman, Duren said he had set three requirements for an institute site: "(1) a resort location where families of mathematicians can accompany them and have a family vacation, (2) a place where costs are within a teacher's budget, and (3) a place where negro and white teachers can meet together."

Duren's trip was fruitless. As he told Price:

> ". . . We are not trying to cure any social ills, but we feel it would be a mistake to start such a summer institute on a segregated basis; if it is segregated, it ought to be for negroes.
>
> "The small religious colleges will meet the third requirement, but not the first two. The YMCA assembly would lease space for a shorter period, but not for six weeks. No university meets any of the three requirements. I doubt therefore that we will have much to offer for any discussion of a summer institute for next year in the Southeast."

It turned out that Duren was unduly pessimistic. Shortly after making this report to Price, he met Prof. G. S. Bruton, of the University of the South, Sewanee, Tenn., who said his institution could meet the three conditions and would submit a proposal for 1954. In

the meantime, Dr. William L. Whyburn, another regional committee member, arranged for his institution, the University of North Carolina, to submit a proposal for that summer. In a letter to Price, Whyburn specified that North Carolina could provide dormitory, dining, and other facilities on a nonsegregated basis. Choosing between the two proposals, NSF supported the latter.

Duren's approach, however, was in line with the thinking of Waterman, Kelly, and other top NSF officials, and the principle was established with the 1954 program that the Foundation would not support segregated institutes.

The NSF and associated FAE institutes in 1954 were described in a staff paper, titled "Reports and Reflections," by Dr. Eugene P. Northrop, who came to NSF at the beginning of that year to handle the education in the sciences program (the name had been shortened from research education in the sciences in the fall of 1953). Rejecting the title of "program director" as "a vacuous title in the absence of a program," Northrop chose to work as a consultant, technically remaining in the employ of the University of Chicago during the year and a half that he was with NSF. Highly articulate and with the logical approach characteristic of a mathematician, Northrop's analysis of the 1954 program helped clarify NSF's goals in teacher training generally and in the administration and operation of summer institutes in particular. He made such points as these:

**Subject-matter orientation. "Left to himself, what the teacher thinks he needs is rather enlightenment and agreement with others about aims, courses and classroom presentation—witness the topics debated in the short (i.e., 3 to 10 days) conference-workshop that has become so popular in recent years. Perhaps it is because a teacher's inadequacy in teaching is simpler for him to recognize than his ignorance in subject matter, or the inadequacy easier psychologically to admit. But it is hard to see how the teacher can be expected to be clear about aims, courses, and classroom-presentation without up-to-date knowledge and a firm grasp of his science."

**Institute courses. "By and large, lectures and discussions for the summer institute need to be designed especially for it. Standard course offerings are generally not appropriate for inexpert teachers whose time is short. Nor are lecture series with so narrow a context that they are likely to attract graduate students and research workers. It would be both difficult and foolish, however, to attempt to prescribe a single pattern of activities for all summer institutes."

**Program length. "Clearly four weeks or more are required if anything more than a superficial educational experience in sub-

ject matter is to be hoped for. Moreover, one of the most widely acclaimed features of the institutes is the opportunity they offer participants for *extended* informal conversations—the teachers with the lecturers on science and its presentation, the high school group with the college group on articulation of their programs, and all with colleagues from near and far on all that comes under the general heading of shop talk."

**Living arrangements. "The extended informal conversations just referred to cannot take place if, following the formal daily activities of the program, the lecturers vanish into their offices or off-campus homes and the participants scatter to widely separated study or eating or sleeping quarters. All participants—not just men, or just women, or just those without spouses or without children—but *all* participants should be housed in one building."

Northrop shaped the summer institutes program for 1955 along the lines indicated in his staff paper and clauses incorporating some of the points he considered most important were included in the "letters of understanding" sent to the directors of the 11 institutes that received grants.

Of special importance was the final clause in these letters which made official NSF's policy on nonsegregation in institutes. It provided that "no person be barred from participation or be the subject of other unfavorable discrimination solely on the basis of race, creed, color, or religion." Just what difference NSF staff members saw between "creed" and "religion" is not clear, but that is how the clause read and the same wording was used in 1956. The colleges and universities receiving grants for summer institutes had to conform to this policy, and a number of proposals actually were turned down, discouraged, or withdrawn because of NSF's insistence on it.

To provide greater uniformity in the program and to assist the men who would manage institutes in 1955, Northrop arranged a conference for the directors in Chicago on January 24–25 of that year. This proved to be the first in a series of such meetings that NSF held annually for those in charge of institutes programs.

Notifying directors that their proposals were being approved and that they or their chief assistants should attend the Chicago meeting, Northrup also cleared up several points of terminology that had been bothering the NSF staff. Following his opening line of these December 23 telephone conversations—"Merry Christmas! I bring you what I hope are tidings of great joy," Northrop asked the directors to use the words "stipend" and "institute" in their publicity rather than "fellowship" or "scholarship" and "conference" or "program." NSF has since adhered to this nomenclature.

The 11 summer institutes in 1955 included five for college teachers, four for high school teachers, and two for high school and college teachers together. Of the six that were open to high school teachers, two were in mathematics, one in chemistry, one in physics, and—for the first time—two institutes covered more than a single scientific area. These last two, predecessors of the multiple-field institutes of today, were at Pennsylvania State University and Oak Ridge Institute of Nuclear Studies. The Penn State Institute included chemistry and physics, while the one at Oak Ridge emphasized those two subjects plus mathematics and radioisotope techniques.

WITH THE EXPANSION IN 1955, SEVERAL INSTITUTES collided head on with a problem that Northrop had hinted at in his staff paper: High school teachers, accustomed to a diet of methods courses and workshops, often were taken by surprise when they found themselves in the intensive subject-matter study atmosphere of the longer institutes. The reverse of this coin was that a number of college teachers, who had joined institute staffs expecting to lecture at relatively sophisticated levels, learned for the first time how basic were the needs of most high school teachers. Adjustments that this situation required both parties to make were not accomplished without some emotional trauma.

To illustrate, high school teachers at a combined high school-college teacher institute in physics at the University of New Mexico nearly staged a "revolt." After the initial lecture, a number of the teachers realized they were in academic deep water and a spokesman for the group complained formally to the institute director that, among other things, the course was "unreasonable in the degree of mathematical manipulation that was expected on the part of the high school teachers."

This led to an open discussion, described by the director in his report to NSF as a "sometimes lively exchange of opinion." When one teacher objected from the floor that the course material "is not something we can take back to our high school students," the lecturer replied that he "had no intention of giving them something that could be directly regurgitated to students in the fall semester, nor did he think that this had been the director's intention."

Upshot was that the institute schedule was rearranged to allow additional time for discussion of methods of presenting material in

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classrooms. According to the director, however, the "upheaval" inevitably did affect the lecturer's presentation and "he could not teach the course at the level to which he had originally aimed." The high school teachers wound up with good marks for the institute—all A's and B's—but the director noted, "Although it would have been desirable to have given a final examination it did not seem wise." He added, however, that toward the end of the institute many teachers "expressed their appreciation of having had a good subject-matter course after all."

The expansion to 11 institutes in 1955 and a further increase in 1956 to 25 summer institutes (18 of them attended by high school teachers) resulted largely from budget decisions made during 1954. These decisions reflected a growing concern at top governmental levels over the apparent shortage of scientists and engineers in the United States, particularly when compared with indications of mounting Soviet scientific strength. For example, according to estimates made by NSF in connection with its fiscal year 1955 budget request, Russia was expected to graduate 40,000 engineers in 1955—nearly twice as many as the United States.

Discussion of manpower figures such as these at a Cabinet meeting prompted President Dwight D. Eisenhower to ask Dr. Arthur S. Flemming, then Director of the Office of Defense Mobilization, to organize a special Cabinet-level committee to study the training of U.S. scientists and engineers and to call public attention to the need for increased American efforts in this area. This group held a number of meetings during the summer of 1954 and in its final report to the President, submitted in October, urged that NSF's role in science education be enlarged.

Reacting to these recommendations, NSF began to expand the education in the sciences program. Budget allocations for fiscal year 1955 were readjusted to put more emphasis on education and, after an appeal from NSF to the Bureau of the Budget in November 1954, the Foundation's proposed request for fiscal year 1956 was revised to include $2 million rather than $500,000 for science education programs.

With the increase in the amount targeted for education, that area received special attention at congressional hearings on the fiscal year 1956 budget request. Members of the Subcommittee on Independent Offices of the House Appropriations Committee were interested particularly in the implications of Federal control over education and the chairman of the House group, Representative Albert Thomas (Democrat, of Texas) questioned Waterman closely on that subject.

Many House Members apparently were not concerned about—or did not understand—the significance of the disparity between

the Russian and United States scientific manpower training figures. They voted NSF an appropriation of $12,250,000, the same amount it had received the previous year. This was done although Waterman tried to bolster NSF's case prior to the hearing by sending the subcommittee members data from a forthcoming book, "Soviet Professional Manpower," which had been sponsored by NSF and the National Academy of Sciences-National Research Council. In an interview with the authors after leaving NSF, Waterman said, "The House committee wouldn't believe it at the time. They thought it was just a lot of propaganda."

The Senate, however, which normally is more generous to NSF than the House, approved the full $20 million requested for NSF. Members of the House and Senate split the difference between the two bills in conference and NSF emerged with a final appropriation of $16 million. While this meant NSF could not spend quite as much as it had wanted on education in fiscal year 1956, the budget increase did put institute expenditures beyond the million dollar mark for the first time.

The program expansion that year was not just quantitative. The 18 summer institutes for high school teachers branched into new fields, including astronomy, biology, and radiation biology, while continuing to provide coverage in chemistry, mathematics, physics, and the multiple-field category. The three radiation biology institutes that summer were financed jointly by NSF and the Atomic Energy Commission, thus beginning a cooperative effort that has continued to the present time.

Another important 1956 innovation was the recognition that institutes could be used for upgrading teachers. Previously, the standard institute pattern had been to concentrate on bringing the best high school teachers up to date on recent developments or modern approaches in science and mathematics. It was more or less assumed that the participants would have an adequate grasp of the material they already were teaching. The experience of institutes in 1955, however, showed that many more teachers were weaker on fundamental aspects of their subjects than either NSF or the university professors who directed and lectured at institutes had realized. As a result, NSF began to depart from the established pattern and in 1956 supported, for example, an institute in natural sciences at the University of Arkansas which was designed expressly for teachers with a bare minimum of college training in science and mathematics.

The Appropriation Increase For 1956 Also Enabled NSF to complement the summer institutes with a new institute program for high school teachers: academic year institutes. The first two academic year institutes were held during the 1956–57 school year at University of Wisconsin and Oklahoma State University.

The academic year institutes program was an important landmark for NSF because of the manner in which it attracted the attention of the House appropriations subcommittee at a hearing on the Foundation's budget request for fiscal year 1957. Prior to this hearing, held January 30, 1956, institutes were still a minor activity within a relatively small agency. After this hearing, they were on their way to the $43-million-a-year program they were to be for the first half of the 1960's. Moreover, as a result of this hearing and from the events that immediately followed, it was determined that most of this expansion would come in the form of dollars tied specifically to support of programs for high school teachers only.

This hearing was prefaced by several actions at the Presidential level that helped focus attention on education. Two months previously, the first White House Conference on Education had been held and earlier in January the President had proposed to Congress a large program of Federal aid to the States for construction of more classrooms. That same month, in line with the recommendations of the Flemming committee, the President's Economic Report had declared that "special attention should be given to the need for better high school instruction in science and mathematics" and urged that NSF be given an enlarged appropriation for this purpose.

NSF went into the January 30 hearing with an overall budget request of $41,300,000. Of this amount, $850,000 was for summer institutes for high school and college teachers and $3 million was to expand the academic year institutes for high school teachers. In comparison, the fiscal year 1956 appropriation had provided a total of $1,123,450 for institutes—$618,750 for summer institutes and $504,700 for academic year institutes.

It was apparent right away that the attitude of the House Members had undergone a dramatic change. The study of Russian manpower that Waterman had drawn upon the previous year in an unsuccessful attempt to support the NSF budget request now had been published and the committee members had had time to consider its

message. Representative Thomas, chairman of the subcommittee, declared near the start of the hearing:

> "This little book, Soviet Professional Manpower, I have read word for word, including most of the tables, and after reading it I completely reversed my thinking, too, just like you [referring to a National Science Board member] said you reversed your thinking.
>
> "Of course we do not have to tie it to Russia by any means, but we found out what Russia is doing. This is the most alarming situation that I can imagine. . . . If this is true, and I have no reason to doubt what it said in this book, in another 5 or 6 years they are going to be ahead of us. Lord help us if they ever reach the point where they are ahead of us, and they are too close to us now."

The House Members emphasized that they regarded teacher training as one of the best things NSF was doing—perhaps even more valuable than other activities, such as support for basic research facilities and policy studies, which were closer to the hearts of many NSF officials. Thomas said:

> "You are striking out on something new now. You are going right at the fundamental thing, this shortage that is created by a lack of high-school teachers. When you start doing work like that, you are really striking something that is valuable to the whole Nation.
>
> "The other program of supplying funds for research equipment, whether or not the committee is going to push along that line, too, in the way of encouraging you I do not know. But get away from evaluating work and spending four or five hundred thousand dollars in bookkeeping, evaluating, and sifting here and there.
>
> "I think you have a fine program but I believe you can cut out some of the paperwork. Train your manpower, that is what you need."

Within the educational sector of NSF's proposed budget, the House Members zeroed in on academic year institutes, indicating several times during the hearing that they would be willing to increase this item. Thomas said:

> "Certainly you ought to pursue this new program that you started for the training—I think the word 'refresher' is not a very accurate word—courses for your high school instructors which is estimated to cost $3 milion this year. If you can use $9 million, or $10 million, we are certainly prepared to give it to you. You are really striking at something worthwhile."

The question finally was put directly by Representative Joe L. Evins (Democrat, of Tennessee):

Mr. Evins. Could you use $10 million instead of $3 million for the high school teacher training program at this time?

Mr. Waterman. I believe we could.

Mr. Evins. In the fiscal year 1957?

Mr. Waterman. I believe so; do you not think so, Dr. Kelly?

Mr. Kelly. Ultimately. One of the programs that we are most enthusiastic about is this summer program, the free time of the teachers during the summer, which we could and probably should exploit to the limit of expanding the summer institutes program in such a way that we can do three things: One, to increase their subject matter knowledge of the science, make them feel a part of the community of science, getting better relationships between the high schools and colleges and then, in addition, to increase their yearly salary in keeping with their monthly salary so they will not have to go out tending gasoline stations during the summer. So that we could expand this program."

At this point, the hearing became confused. The original question had referred to the academic year institutes and Waterman's reply had amounted to a "yes." But Kelly had qualified his reply with the word "ultimately" and had phrased his answer in terms of the summer institutes. After some minutes of discussion had failed to make clear in which of the two programs the $10 million could be used and whether it could be used in 1 year or over a 3-year period, Thomas asked Waterman to "send us a little note in the mail tomorrow on this, please."

Another subcommittee member, Representative John Phillips (Republican, of California), pursued this idea further. He asked Thomas just what the "little note" should contain. Was the subcommittee suggesting "that the education of high school teachers should come ahead of everybody else?" If so, Phillips said, the memorandum from Waterman should tell "where in other parts of the budget the agency would like the money transferred from as being of lesser emergency than what we are talking about right now." Thomas agreed this approach made "a lot of sense."

NSF had now arrived at a moment of decision. As one man who for many years has been close to NSF affairs put it, "That was the night the Foundation searched its conscience." Waterman years later described it as "searching for justice" and added, "The NSF conscience was always active!"

The Congressmen had shown they were ready to give NSF more money than had been requested for the programs for training high

school teachers and NSF officials had indicated they were willing to go along with this. But Phillips also had made it clear that expansion in this area would have to come at the expense of other NSF activities. When the question was put this way, NSF decided to decline with thanks the subcommittee's proposal of $10 million. In a letter to Thomas on February 3, 1956, Waterman explained:

> "The budget proposed by the President for the Foundation for fiscal year 1957 represents a substantial increase over previous years and provides a balanced approach to the Foundation's responsibility for promoting progress in the numerous problem areas confronting us in science today. It is important that we continue to apply available funds in a manner that will ensure necessary progress in each of these important areas, most of which also contribute in effective ways to the training of scientists.
>
> "Therefore, after consideration of the matter, I do not believe that the Foundation should increase its Education in the Sciences program at the expense of other Foundation activities."

Before sending this letter, Waterman consulted with the Chairman and Vice Chairman of the National Science Board and cleared the reply by telephone with members of the Board's executive committee. The Bureau of the Budget also reviewed the letter but, Waterman said in a 1964 interview, "did not dictate it." Discussing the reasons NSF took the position it did, he added:

> "When a committee asks you what you would like to have, you have to watch your step. As a loyal member of the President's Administration you are obligated to defend his program and to consult with the Budget Bureau. However, when you are asked the question 'What can you use?', you have somewhat more latitude and can—while still staying within the rules—speak your mind.
>
> "In this case, the Budget Bureau didn't want to increase the NSF budget. If it did, it would have to make a cut somewhere else to bring the overall budget into balance. And our view was that we didn't want to take money away from basic research."

The decision thus reflected the continuing belief of many NSF Board and staff members, most of whom had research backgrounds, that NSF should concern itself primarily with basic research and graduate fellowships—items that came under the general heading of "pure science." Individuals who were active in NSF at that time recall that a number of other factors also contributed to the answer sent to Thomas.

One of the most important apparently was the fear that the quality of the institutes would be compromised if the program were expanded

too greatly. Up to this point, there had been much emphasis on obtaining "name" scientists and mathematicians to staff institutes and the number of people in this category obviously was restricted. According to a staff paper written 6 months before this hearing, it "almost surely would be impossible to expand the number of Summer Institutes to, say, 100 and maintain the present quality." This paper reported that some observers felt "the upper limit" for institutes for high school teachers was "about 30." On a purely practical level, there also was some question whether NSF could staff and manage such a rapid growth in one part of its budget during a single year.

Despite NSF's reply, the committee and later the House went ahead and voted a large increase for the teacher-training programs. The independent offices appropriation bill for fiscal year 1957, approved by the House on March 7, 1956, included $35,915,000 for NSF. And attached to the NSF section of the bill was a clause which "Provided, That . . . not less than $9,500,000 shall be available for tuition, grants, and allowances in connection with a program of supplementary training for high school science and mathematics teachers." Through this action, the House cut the total budget request for NSF by $5,385,000 but, at the same time, increased the amount available for institutes by $5,650,000 above the proposed figure. The net result left NSF officials unhappy on two counts: (1) plans for expansion of research programs would have to be curtailed, and (2) comparatively little money would be left in the educational budget for programs other than those for high school teachers.

Acting for NSF after the House bill was approved, Waterman made two attempts to have the restrictive $9,500,000 clause removed. He appealed to the Senate Appropriations Subcommittee on Independent Offices to delete the clause, declaring, "we dare not concentrate all of our efforts on training only high school science teachers." He also asked Dr. Frederick A. Middlebush, a member of the National Science Board and a past president of the University of Missouri, to present NSF's case directly to Representative Clarence Cannon (Democrat, of Missouri), chairman of the House Appropriations Committee.

The Senate acceded to Waterman's request, voting NSF $41,300,000, the full amount proposed in the President's budget, without specifying what portion of the money was to be spent on programs for high school teachers. However, the final bill that emerged from conference between Members of the House and Senate and which was approved by Congress on June 20, appropriated $40 million for NSF—more than initially voted by the House—but retained the provision that "not less than $9,500,000 shall be available" for "supplementary training for high school science and mathematics teachers."

This phraseology, which has been continued in subsequent NSF appropriation bills, came to be known within the Foundation as the "limitation clause." Normally, the word "limitation" implies a boundary beyond which one can not go and, in a budgetary sense, a limitation clause would appear to be a device for preventing an agency from spending more money on some favorite program than Congress desired. In this case, the reverse was true. Congress gave NSF more money for training high school teachers than had been requested and, by applying the limitation clause, sought to insure that these dollars would not be siphoned into other programs. The dollars were being "limited" to a particular use.

Commenting some years later on the reasons of the House for introducing this clause, Waterman said:

> "What really sold the institutes program was the enthusiastic reaction of the high school teachers. They thought the program was good and wanted to go—and they told their Congressmen so. This was the one program of NSF that had a wide impact politically."

Thomas, recalling the subcommittee's thinking, said:

> "We believed this was perhaps the most important thing the Foundation was doing. The clause earmarking $9,500,000 for training high school teachers was approved because we wanted to insure that this program received the proper attention and would not be slighted."

The expansion of the institutes programs during fiscal year 1957 changed the overall NSF posture. From 7 percent of the Foundation's obligations in fiscal year 1956, institutes jumped to 24.9 percent in 1957. Basic research, while receiving more dollars for 1957, dropped from 59.2 percent in 1956 to 39.5 percent in 1957.

The institutes programs in 1957 for the first time attained a truly national scope. The number of summer institutes rose from 25 (18 of them open to high school teachers) the previous year to 96 (91 of them for high school teachers), with institutes in 43 States and three territories. In addition, the fiscal year 1957 appropriation provided funds for 16 academic year institutes and permitted NSF to start a third training program for high school teachers: In-service institutes. Two of these were held in the spring semester of 1957 at Reed College, Portland, Oreg., and Antioch College, Yellow Springs, Ohio, and the program was expanded to 21 for the 1957–58 school year.

The Growth of the Summer Institutes Program in 1957 had one ironic effect. NSF's policy on nondiscrimination, exemplified by the "race, creed, color, or religion" statement in the letters of understanding sent to institute directors in 1955 and 1956, appealed to some Members of Congress who had been attempting to write similar provisions into bills appropriating Federal funds for education and apparently was an important factor in the support its budget request received. Discussing the reasons for the fiscal year 1957 appropriation increase, Kelly recalled years later:

> "I was asked about three times during off-the-record portions of the [House] hearings if anyone could go to an institute. One Congressman even crossed over to my side of the table and asked specifically, 'Do you mean any teacher, even a teacher from a parochial school, can go to an institute? Are institutes open to Negro as well as white teachers?' I told him, 'Yes,' and that we were solely interested in the advancement of science. I think this argument was the clincher."

The appropriation increase, however, led to a change in the nondiscrimination policy that had made the institutes attractive to this segment of congressional opinion. More money meant more institutes in the Nation generally and—if NSF was to follow the intent of Congress expressed in the act establishing the Foundation and distribute grants throughout the States—in the South particularly. But, southern mores being what they were, there appeared to be relatively few institutions which would agree to NSF's nondiscrimination policy. Faced with the possibility of providing poorest institute coverage in that section of the country which many observers believed needed the program most, NSF replaced the "race, creed, color, or religion" clause with a more general statement for 1957. As contained in a "Fact Book" distributed to institute directors that year, it was underlined and read:

> *"Each institute will establish its own criteria for admission within the general Foundation policy that candidates shall be considered primarily on the basis of professional competence and promise as teachers of science and/or mathematics."*

Other factors, including the attitude of the Eisenhower administration and the legal battles being conducted in the aftermath of the Supreme Court's 1954 decision striking down public school segregation, contributed to the NSF policy change. In December 1956, when Waterman telephoned a White House aid to discuss the racial problems involved in a summer institute proposal for 1957 from a Texas institution, the aid suggested, according to Waterman's record of the call, that "the important thing is of course to avoid having a burning issue arise." The following spring,

an NSF staff member in charge of summer institutes, after referring to the conflicts between State and Federal laws in a memorandum on admissions criteria, declared that barring issuance of "a clear executive order stating Foundation policy with respect to racial criteria . . . it seems impossible for the Foundation to clearly justify a stand where the law is in doubt."

As a result of this policy change, NSF made grants for the first time for summer institutes in 1957 to such institutions as University of Mississippi and University of Alabama, as well as to colleges attended exclusively by Negroes. While the word "discrimination" was not mentioned openly in NSF regulations during the years that this policy was in effect, up to 1962, Foundation officials attempted in a quiet way to foster integration when and where they could.

Occasionally NSF's efforts paid off. Dees, who succeeded Kelly as head of the SPE Division in 1959 and continued in that post until 1964, claimed, "We know that about a dozen schools had Negroes as students on their campuses for the first time as a result of the institutes programs."

At the same time, some instances of discrimination occurred after the 1957 policy revision. Perhaps the most blatant was the case of a private university in the South which withdrew a stipend offer to a woman teacher after it discovered she was a Negro. The teacher had mistakenly filled out her application in blue instead of black ink as directed, but the institution had accepted her despite this error and asked her to fill out another application and return it together with a photograph of herself. After the new application and the picture arrived, the university decided to withdraw the stipend offer on the grounds that she had not initially followed instructions. NSF staff members arranged for her to attend another institute.

The year 1957 also was a breakpoint in the history of the institutes programs in a number of other respects:

**Because of the increase in appropriations and a corresponding rise in the number of requests to hold summer institutes, NSF found it impractical to continue evaluating proposals by sending them out for review to scientific society committees. Instead, the evaluation of proposals for 1957 was done in Washington by a specially appointed panel of scientists, mathematicians, and educators. This was the first of the temporary panels asked in succeeding years to advise NSF on which institute proposals to support.

**Distribution of the previously mentioned "Fact Book" to institute directors in 1957 represented a crystallization of administrative policies that have not changed much since. The "Fact Book" was the forerunner of the guides published annually for directors

and many of the statements in the 1957 booklet were carried almost word-for-word in its 1965 successor.

**NSF representatives made formal inspection visits to about two-thirds of the summer institutes in 1957, initiating a system that continued in subsequent years. Reports on these visits helped NSF learn what really happened in the projects NSF supported and aided the Foundation staff in deciding which institutes were to receive renewal grants in following years.

**After several years of experimentation with lower stipends—during which some institute directors had difficulty filling quotas, apparently because teachers could not "afford" to attend—NSF established for 1957 the participant support structure still used in summer institutes in the mid-1960's. Stipends were set at a maximum of $75 per week, dependency allowances at a maximum of $15 a week per dependent up to four, and each participant was given a travel allowance of not more than 4 cents a mile up to a maximum of $80 for one round trip between his home and the institute.

More generally, but most importantly, the 1956 decision of Congress to raise the appropriation for institutes for high school teachers meant that NSF had a summer's experience managing a relatively large-scale operation prior to October 4, 1957, when the launching of Sputnik I by Russia precipitated demands for still larger institutes programs.

UP TO THE TIME THE SOVIET SPUTNIK WENT INTO ORBIT, no important increases beyond the 1957 spending level were planned for the following years' institutes programs. Institutes still were considered by some NSF officials to be in the "experimental" category and, rather than expand the programs, these Board and staff members were looking forward to the day when the Foundation could begin to phase out support of institutes. It was hoped that two things would happen to permit this: (1) Private foundations and industry would enlarge their educational activities, following the example set by NSF, and (2) colleges and universities would incorporate institute-type courses into their regular curriculums. In addition, NSF wanted to devote a greater portion of its educational dollars to new programs being developed at this time, such as the Physical Science Study Committee project to produce a new high school physics curriculum.

Congress, which had been responsible for the major size increase

in institutes in 1957, also was standing pat. It appropriated $40 million for NSF for fiscal year 1958, the same amount the Foundation had received the previous year, and the limitation clause for programs for high school teachers was continued at $9,500,000.

NSF continued during the summer of 1957 to mount these programs in a conservative fashion. Estimates for fiscal year 1959 sent to the Bureau of the Budget 2 weeks before sputnik included $10 million for institute activities. The only increases proposed, small ones at that, were for summer institutes for college teachers and in-service institutes for high school teachers.

All estimates were upset after October 4, however. Launching of the Soviet sputnik that day—an event described by Waterman the following month as a "scientific Pearl Harbor"—shook the American public. Suddenly the United States was second best, an unfamiliar and uncomfortable position. Many people believed the United States had lost a scientific and technological competition despite President Eisenhower's press conference statement that the administration had never regarded the American and Soviet space programs "as a race."

Soon investigators and critics arrived on the scene. One of the obvious whipping boys was the Nation's educational system. After all, it was the schools which produced the scientists and engineers who came in second—so something must be wrong with the schools. A critical examination of the entire educational system began, accompanied by a rising chorus of voices demanding that the Government "do something." In the center of the spotlight was science education and here, of course, the Government's chosen vehicle was NSF. Attention focused on its on-going educational programs, designed to treat the ills that were the subject of so much debate.

Thus the administration and Congress did not face the task of creating something new—at least not immediately—in order to accede to the ground swell of public opinion. The only question was how big to make the programs that already existed.

NSF's budget was boosted in two ways: It received permission from the Bureau of the Budget to seek a supplemental appropriation for fiscal year 1958 and to submit a revised budget request for fiscal year 1959.

November and December were months of frantic work for the NSF staff. Mimeograph machines ran far into the night as budgets for the SPE Division were written and rewritten in an attempt to compress a planning job that normally took about a year into the much shorter time span. Recalling these weeks, Dees said:

> "We worked weekends and nights, 'til midnight or 2 a.m. Our proposed budgets went up as high as $300 million with one including funds for equipment grants—something that was

later accomplished to an extent through the National Defense Education Act."

Howard F. Foncannon, then an assistant to Kelly, also had vivid memories of this period. "Starting with the budget that had been originally submitted to the Budget Bureau on September 30 as 'Budget A,' we wrote and rewrote, and wound up 'Budget G,' which was the one that finally went to Congress," he said, adding:

> "We had no real guidelines. The Bureau of the Budget just told us to create a program that would meet the national interest. We dragged out and reexamined programs that had been proposed in the past and filed away because we didn't have enough money for them at the time. We also wrote in some new programs. One of our worries was that, without small trials, some of these would turn out to be lemons. But we didn't have time for trials. On the whole, we were miraculously lucky."

The budgets finally sent to Congress asked for a supplemental appropriation for fiscal year 1958 of $9,900,000, of which $1,415,000 was requested for institutes programs, and for fiscal year 1959, a total of $140 million for NSF, of which $35,500,000 would be devoted to institutes of all types.

Recalling the specific reasons for more than trebling the estimate for institutes from the September figure of $10 million to the January request of $35,500,000, Waterman said the final budget for NSF was worked out in three-way discussions of the Foundation, the Bureau of the Budget, and the President's Science Advisory Committee. This latter group had been enlarged and transferred from the Office of Defense Mobilization to the Office of the President shortly after sputnik. With the budget having "been thrown wide open," Waterman said the President's Science Advisory Committee "was strongly in favor of the programs for training teachers" and recommended their expansion to the President.

The revised and expanded NSF budget received enthusiastic support from President Eisenhower. In a special message on education on January 27, 1958, he described the Foundation's programs "as among the most significant contributions currently being made to the improvement of science education in the United States." The President also made legislative recommendations in this message for additional Federal programs in education which resulted in the National Defense Education Act of 1958. This act greatly enlarged the role of the Office of Education. Among other things it authorized the Office to establish institutes patterned along NSF lines for guidance counselors and for teachers of foreign languages.

In the atmosphere of crisis induced by sputnik, both the supplemental budget request for fiscal year 1958 and the full request for

fiscal year 1959 went through Congress relatively unchanged. For 1958, NSF received an additional $8,750,000, only $1,150,000 less than the supplemental appropriation asked. Importantly, Congress again showed its partiality for the programs for high school teachers and used a limitation clause to specify that not less than $2,367,000 of these additional funds should be used for this purpose. This was $952,000 more than had been requested in NSF's proposed supplemental budget for institutes for high school teachers.

For fiscal year 1959, Congress appropriated $136 million for NSF, shaving the requested budget by only $4 million. A limitation clause again was enacted but this time the clause earmarked exactly the amount that had been requested for institutes to train secondary school science and mathematics teachers—$30,250,000.

As a result of this quantum jump in appropriations, the number of summer institutes open to high school teachers rose from 91 in 1957 to 121 in 1958 and then soared to 318 in 1959. The other institutes programs for secondary school teachers also expanded greatly, with the 1959 appropriation providing for 32 academic year institutes and 184 in-service institutes.

The sputnik increase also permitted NSF to diversify further its institute offerings. The number of summer institutes at the college level rose. Special summer institutes were added for teachers from technical schools. College teachers were admitted to academic year institutes for the first time. A new program of conferences for college teachers was established. Summer and in-service institutes programs were organized for teachers from elementary schools.

In 1959, NSF's institutes programs reached what is essentially their present shape. Programs introduced since that time have included in-service institutes for college teachers in 1963 and conferences for high school teachers in 1964. As of 1965, both of these remained small.

During the months after sputnik, there were many indications of a change in the thinking of National Science Board and staff members. For example, testifying at the House hearing on the fiscal year 1959 budget request, Dr. Samuel M. Nabrit, National Science Board member and president of Texas Southern University, Houston, said:

> "Frankly, a year and a half ago I think many of us would have been somewhat reluctant to say a program as large as the one we now have in high-school teacher improvement was the most important phase of improvement in science.
>
> "Today, after having had first hand experience and having followed some of these institutes and seen the values that accrue to participants, we think that this is one of the most worthwhile investments which has been made in the entire field of science,

because in this way we can broaden the base of competence from which we can draw talent in the future."

In February 1958, a month after this hearing, Kelly pointed out at a meeting of the SPE Divisional Committee that the institutes programs had been regarded in the past as experimental and that "we have always emphasized quality." Now, he said, the problem had to do with numbers as well. "Although since sputnik, there is a general concern about education and the need for quality in all education, science included, there must be developed an awareness of the need on a permanent, not merely emergency basis," he declared.

The new attitude toward institutes was reinforced in a number of ways. NFS's authority to act in the field of science education was bolstered. In planning for NDEA, officials of NSF and the Office of Education agreed on a line of demarcation between the Foundation and the Office in the Federal educational establishment. As described by President Eisenhower in his 1958 message on education, NSF's domain was to include those programs which "deal exclusively with science education and operate mainly through scientific societies and science departments of colleges and universities." On the other hand, the Office of Education would work through the States and local school systems to strengthen both science education and general education. In line with this agreement, one of a series of amendments in 1959 to NSF's enabling legislation was designed to make clear the Foundation's authority to conduct large and continuing educational programs.

It also became obvious during 1959 and 1960 that, contrary to NSF's original hopes, neither industry nor the colleges and universities were going to take over a substantial portion of the teacher-training job from the Foundation.

As early as 1957, NSF had noted the "intimidating effect" of its efforts on industrial programs for training science and mathematics teachers. This trend reached a climax in 1959 when, following expansion of the NSF institutes for high school teachers to 318, General Electric Co. brought to an end what had been the largest privately financed program of this type. GE company officials had become interested in similar experimental programs for social science teachers and guidance counselors. Before GE switched support to other areas, seven colleges and universities had participated in its program and the company had spent some $1,500,000 to train approximately 2,500 high school science and mathematics teachers.

At the same time, few colleges and universities were assuming the financial burden of training in-service teachers. Many of the special summer session courses for high school teachers, in fact,

had been replaced almost immediately by NSF institutes or brought into the institute framework. On the one hand, teachers wanted to go to the institutes because they offered stipends; on the other, colleges and universities were happy to have NSF pay the costs of holding the special courses. Queries of institute directors and a formal study of the possibility of phasing out the academic year institutes program showed that educational institutions were not eager to reverse the trend. For example, a poll of directors of summer and academic year institutes in 1958 showed that, by a margin of about 3 to 1, the directors believed Federal support was essential for continuation of their programs.

Illustrating NSF's increased awareness of the permanency of the institutes programs was a decision to begin, starting with the 1960 programs, an allowance for indirect costs in grants for summer and in-service institutes. (Such payments had been made in the case of the more expensive academic year institutes since that program began.) One of the main reasons NSF had not provided previously for indirect costs in the summer and in-service institutes was that it regarded the expenses the colleges and universities incurred by absorbing these costs as an indication of their interest in the institutes and as a token of NSF' own intention eventually to reduce support in this area. As the summer institutes program expanded, however, NSF came under increasing pressure from universities to foot the entire bill. Discussing the decision to start paying indirect costs, Waterman said in a memorandum to the Board in March 1959, that "although we would like to see it otherwise, it does not appear realistic to entertain hopes of 'phasing out' this program in fiscal year 1961."

AN IMPORTANT RESULT OF THESE DEVELOPMENTS WAS that NSF began organizing institutes on a long-range basis to meet long-range needs. This led to what were probably the two most significant program changes of the postsputnik period—the development of sequential institutes and multiple-year funding.

Evolution of sequential institutes took place almost as a sub rosa development. Prior to 1959 some directors had begun inviting teachers to attend their institutes for several years in a row so that they could complete programs leading toward masters' degrees. Freuently these were special degrees with science education overtones, such as master of science in teaching, master of science education, and

master of natural science. (Appropriately enough, since many of these special degrees were established specifically to meet the needs of institute participants, this last one was jokingly referred to a "master of national science" on more than one campus.) Any director who began such a sequence in effect "gambled" that NSF would support his proposals in future years. But because NSF did not mention such programs in its literature, most directors played down this aspect of their institutes or did not mention it at all in submitting new proposals.

As a result of the large budget increase for 1959, however, NSF had some money left over after financing the 318 summer institutes for high school teachers for that year and decided to make early grants for 1960 for eight institutes whose 1959 proposals indicated clearly they had worked out sequential patterns. The same thing was done on a larger scale in 1960 when 21 institutes received grants ahead of time for 1961.

On the basis of this experience, sequential institutes were recognized officially in 1962 in NSF's national brochure listing summer institutes. They were distinguished from "unitary" institutes which, although they may be repeated for a number of years, are designed primarily for different groups of participants each summer. Of the 421 summer institutes attended by high school teachers that year, 116 or 28 percent were classified as sequential. In succeeding years, the proportion of sequential institutes increased slowly to about one-third of the total.

Starting with the 1962 program, NSF also expanded and broadened its policy of providing long-term support for institutes. Instead of actually making grants a year ahead of time, however, it gave commitments contingent upon future availability of funds to support 126 of the 1962 summer institutes—including institutes of both the sequential and unitary type—for periods of up to 3 years in a row. This practice has been continued in subsequent years with the number of institutes receiving such commitments for 1965 amounting to 146 or a third of the total.

The year 1962 was the only one in the first half of that decade that NSF received an increase in appropriations for programs for high school teachers. The limitation clause, which had been set at $30,250,000 for fiscal year 1959 and held at the level for fiscal years 1960 and 1961, was raised to $37,600,000 for fiscal year 1962, a plateau that was maintained through fiscal year 1965.

Generally speaking, NSF officials during these years took the position that, while more dollars could be used on programs for secondary school teachers, expansion of other activities, such as those for college and elementary school teachers, was more urgent. However, the fiscal

year 1962 increase was approved by Congress in the face of such an argument by NSF officials.

Reflecting NSF's desire to put more emphasis on programs at other academic levels, a reorganization move at the end of 1964 sought to bring the college institutes out of the shadow of the secondary school activities. At a meeting in September, the National Science Board authorized Dr. Leland J. Haworth, who had succeeded Waterman as NSF Director in 1963, to split the Division of Scientific Personnel and Education into three independent divisions. The new units, officially established January 1, 1965, were organized according to educational levels. The Division of Pre-College Education in Science focused on elementary and secondary school programs; the Division of Undergraduate Education in Science, on college programs; and the Division of Graduate Education in Science, as its name implies, on graduate-level programs.

By almost any standard, the potentially stickiest problem NSF encountered during the early 1960's was the continuing one of segregation. While theoretically sidestepping the issue since 1957 when the "race, creed, color, or religion" clause was dropped, NSF faced recurring specific instances of discrimination in the institutes programs and, during 1961, began a gradual shift in policy that was to culminate in a return to a nondiscrimination clause with teeth in it.

While it is difficult to pinpoint the exact moment the change in NSF policy began, it coincides closely with the inauguration in January 1961 of President John F. Kennedy, whose Administration adopted a more aggressive role in the civil rights area, and with the publication that same month of a U.S. Civil Rights Commission report entitled, "Equal Protection of the Law in Public Higher Education."

The Commission report sharply criticized NSF and other Federal agencies for the amounts of money they were granting to segregated institutions in the South, including those open to "whites only" as well as those segregated, in effect, for "Negroes only." Analyzing the NSF institutes programs in seven Southern States for the fiscal year 1960, the report concluded "the existing disparity between public schools for white children and the public schools for Negro children was magnified by providing special training for proportionately more white teachers than Negro."

Additional pressure was brought to bear on NSF in December 1961 when Abraham Ribicoff, Secretary of Health, Education, and Welfare, ordered that a nondiscrimination clause be included in the contracts used by the Office of Education in its NDEA institutes program for guidance counselors and language teachers.

With an official policy change now clearly impending, NSF warned

directors at winter meetings of the coming step. The actual move was delayed until the next spring, however, by a series of discussions between NSF and the White House over the exact manner in which the change would be implemented. The White House apparently wished to avoid issuing a Presidential directive to NSF to adopt a policy similar to Ribicoff's. NSF officials, on the other hand, were reluctant to appear to be acting categorically in such a touchy area.

The final decision, when it was conveyed to Waterman in the form of a memorandum from a White House assistant in May, was phrased in terms of "the President's desire." The new policy applied to summer and academic year institutes and had to be accepted in writing by the president of the requesting institution before a grant would be made. The pertinent clause read:

> "Candidates shall be selected, without regard to race, creed, or color, solely on the basis of their ability to benefit from the program and their capacity to develop as teachers of science and/or mathematics."

This policy went into effect with the summer institutes program for 1963 and the academic year institutes for 1963–64. The decision whether or not to accept the proffered grants was a major one for many southern institutions and, in some instances, it was necessary for governing boards to hold special meetings to consider changing their stated admissions criteria.

The vast majority, including all those that were offered grants for academic year institutes, decided they could accept the new condition. Six institutions, however, washed out of the summer institutes program, either withdrawing their proposals or turning down grants, while a seventh initially declined a grant and then, in March, told NSF that it had decided to change its restrictive admissions policy and received one after all.

NSF continued to strengthen its nondiscrimination policy. The key clause was broadened for 1964 to ban discrimination in "the administration of the project" as well as in the selection of participants and was extended to apply to the in-service institutes program. In addition, NSF's authority to act in this area was bolstered by passage of the Civil Rights Act of 1964 which provided that no person shall be subject to discrimination "under any program or activity receiving Federal financial assistance."

Despite these moves, Negroes still had not been granted stipends to institutes at some colleges and universities as of the end of 1964. However, NSF was trying to keep close watch on how these institutes were operated, sending staff members and consultants to visit them as frequently as possible, and paying close attention to the few letters of complaint that it received from teachers who believed they might

have been subject to discrimination. From the time the new integration policy went into effect in 1963 until mid-1965 when this report was prepared, no complaints were received that provided what NSF officials in Washington considered a clear-cut case of discrimination. Of course, this may have reflected only the reluctance of Negro teachers to apply at institutes in southern colleges and universities where this issue might have been encountered.

Other problems of NSF during the early 1960's stemmed mainly from finances. As one punster put it: NSF was trying in those years to buy "more brains for the buck." It was a difficult assignment. While appropriations for programs for high school teachers were raised only once after the immediate postsputnik increase, the national population of science and mathematics teachers continued to increase annually. The cost of living, including institute expenses, also rose. As a result, a major goal of NSF during these years was to cut costs in order to maintain the relative impact of the institutes.

The institutes programs were shifted slightly after 1960 to funnel proportionately more teachers in in-service institutes, which are the cheapest—and, to some observers, the least effective educationally—type of NSF institute. Institute directors were held to tighter budgets. Restrictions were placed on the expansion of individual institutes. This worked somewhat at cross-purposes with the cost-cutting effort since the expense per participant to NSF tends to decline as the size of an institute is increased. Creation of larger institutes, however, would have forced a reduction in the number of institutes and diminished the breadth of NSF's contact with the academic community. To spread the available money among more individuals, stricter regulations were established to govern the award of stipends to teachers. In 1962, NSF imposed a "32-week or 4-summer" rule limiting the amount of its support any teacher might receive to the equivalent of one academic year. Teachers with this amount of Foundation-financed training were barred from receiving additional stipends to summer institutes more often than once every 3 years. Yet some—probably only a few—have managed to evade the rule because of difficulties in monitoring the applications for more than 400 summer institutes.

NSF also attempted to improve the efficiency of its training system by classifying summer institutes according to difficulty of academic work offered. The classification ranged from "0" for institutes providing "Work at level of introductory course such as might be offered to students who have practically no academic background in the basic subject matter" to "5" for those providing "Work at level comparable to that of the usual graduate courses in the field."

While classification has helped many teachers apply to the institute

for which they were best suited, inevitably some teachers still apply to the wrong institutes for them—perhaps because they overestimate their capabilities or simply because of their desire to attend an institute, any institute, during the summer. And since application forms and even transcripts of records are not infallible indicators of a teacher's true background and ability, a certain number of those who make poor choices in applying do receive stipends.

NSF began financing summer institutes in 1961 for teachers of the social sciences in secondary schools, a practice it continued on a slowly expanding scale (11 such institutes were financed in 1965). Another change was made in 1963 when the NSF staff started to encourage the development of institutes for teachers from restricted geographic areas, citing in its literature the advantages of "an institute designed to prepare teachers to teach effectively a new course soon to be adopted region-wide."

Another innovation began in 1964 with a new program of conferences for secondary school teachers. Only two were held that year and five in 1965. NSF hoped this project would evolve along the lines of the college teacher conferences in which participants who already are well grounded in their subject-matter fields concentrate on recent developments in relatively narrow areas. Since participants in the short conferences do not receive stipends, this means teachers who have exhausted their eligibility for NSF support by attending summer and academic year institutes still have an institute-type program open to them.

As NSF Moved Into The Second Half of the 1960's, the institutes were well-developed, $43-million-a-year programs. Their impact has been international as well as national, the summer institutes having served as a model for the development of similar teacher-training programs throughout Central and South America and in a number of other nations, including India, Pakistan, the Philippines, Denmark, and Nigeria.

In the United States, the most noticeable effect of the institutes has been the manner in which they have assisted the Nation's high schools to adopt new science and mathematics curriculums. Starting with an in-service institute at Bowdoin College, Brunswich, Maine, in 1957–58 and five summer institutes in 1958, which were designed to prepare teachers in the new high school physics course developed by the

Physical Science Study Committee, a portion of the institutes held each year have been devoted either in whole or in part to PSSC and, in subsequent years, to such other curricular revision projects as the Biological Sciences Curriculum Study, Chemical Bond Approach, Chemical Education Material Study, Earth Science Curriculum Project, School Mathematics Study Group, and University of Illinois Committee on School Mathematics.

Typical of the attitude of people associated with these curriculum development projects is a 1964 statement of Dr. Jerrold R. Zacharias, Massachusetts Institute of Technology professor who has been a moving spirit behind the PSSC program. Pointing out that the majority of the 5,000 high school teachers of PSSC physics had been to PSSC-oriented institutes, Zacharias said:

> "The National Science Foundation-sponsored PSSC summer and in-service teacher training institutes have been an essential part of the overall PSSC physics program. They perhaps more than any other single influence have helped make the course immediately available to teachers and students."

Many observers believe that if NSF institutes had not already existed, it would have been necessary to invent them in order to capitalize on the work that has been done to develop new high school courses. Describing the summer institutes as "a natural and necessary appendage" of introducing a new program, Dr. George C. Pimentel, professor at the University of California at Berkeley and director of the CHEM Study or "CHEMS" project, added:

> "I believe that chemistry teachers with strong backgrounds in content can teach CHEMS without too much retraining but the average teacher probably would be well advised not to undertake this change without retraining. This is where the Summer Institutes play a vital role."

While the effects of institutes may be more readily apparent when they are used to train teachers in a specific revised course, most independent observers believe the programs also have been beneficial generally to the Nation. For example:

**While U.S. Commissioner of Education Francis Keppel cited "the bewildering pace of change" as the classroom teacher's "greatest test." Then he added in a 1965 statement to the authors:

> "Changes of these kinds have particularly challenged teachers of science and mathematics—subject areas that have been most pervasively revolutionized in recent times. The challenges are being met, and the institutes programs administered by the National Science Foundation have made a major contribution to our success. Through these institutes, teachers have become familiar with recent advances in their special fields of knowledge.

They have familiarized themselves with new courses of study. They have developed new approaches to learning and teaching—benefiting not only themselves and their students but inspiring their fellow teachers as well.

"Beyond these accomplishments, the NSF institutes program has demonstrated that Federal efforts can produce substantial educational improvement. Its success has led to the development of similar institutes in other subject fields and it has taught the important lesson that the quality of education in the classroom is amenable to swift improvement by concentrating on the competence of the classroom's centrally important figure—the teacher."

**Samuel Schenberg, director of science for New York City's public schools, told a 1962 meeting of the Association for the Education of Teachers in Science:

"The National Science Foundation, through its sponsorship of summer institutes and revisions of existing courses of study on a nationwide basis, is making a highly significant contribution to the improvement of science and mathematics teaching in the junior and senior high schools of our country. . . . In a brief period of a half dozen years the NSF by virtue of the tremendous financial resources at its disposal has demonstrated that a national agency can raise educational standards in every city and hamlet in the United States without infringing upon the rights and control of local school systems."

**Dean B. Roger Ray of the Division of Sciences, Washington State University, Pullman, Wash., wrote in July 1964:

"The Institute Program has been more responsible than any other factor in achieving a substantial upgrading of competence of science and mathematics teachers in secondary schools. I believe it has been the primary factor. We continually see the results in general and specific ways. Each freshman class in the University is better prepared in science and mathematics than the previous one, for instance, as shown by our Mathematics Placement Test scores. . . . Frequently we can correlate the quality of the work given in a high school with a specific teacher who has participated in the Institute program."

**The Rev. C. Albert Koob, O. Praem., associate secretary of the National Catholic Educational Association's Secondary School Department, commented in early 1965:

"The NSF summer institutes for teachers of mathematics and science have had a very positive influence on the quality of teaching in the Roman Catholic secondary schools. When one assesses the value of these institutes it becomes evident that their

contribution was much more than that made to a group of individuals, for they tended to create an atmosphere that looked for up-grading and improvement throughout the entire system."

Because of the size and diffuseness of the institutes programs and the lack of adequate control groups, it is impossible to go beyond such general statements and to measure with scientific precision the impact of these activities. NSF does not even know exactly how many secondary school teachers have received training in summer institutes. It knew that it provided approximately 150,000 "training opportunities" in this program through 1965 and it believed that about a third of the estimated 226,000 people teaching science and mathematics in secondary schools in 1964–65 had been to at least one summer institute.

It is hard not to assume that this amount of training has contributed to a rising standard of instruction in these subjects, and this assumption is supported by followup surveys NSF has made of teachers who have attended institutes. For example, a 1959 study of teachers who had attended summer institutes 2 years previously revealed that 83 percent felt they learned new subject matter during the NSF program. It also appeared that substantial numbers put their new knowledge into use. As a result of their institute attendance, the teachers reported:

Forty-eight percent introduced more advanced material into their courses or broadened their coverage;

Twenty-nine percent brought newer subject matter into their courses;

Twenty-nine percent put more stress on student participation;

Fifteen percent devoted more time to laboratory work;

Fifteen percent made greater use of audiovisual aids.

NSF believes the institutes have had other less tangible, but nevertheless important, side effects such as helping to keep needed high school teachers in the profession by supplementing their incomes with stipends and enabling them to qualify for salary boosts on the basis of institute training. Another significant byproduct in the eyes of NSF officials has been the renewed interest by many faculty members of college and university science departments in the problems of secondary school teachers, helping to close the intellectual gap that previously existed between these two groups.

NSF also made an important contribution by developing institutes as a mechanism for providing Federal support for education without accompanying Federal control. Probably because NSF did not bristle with overt controls, the institutes programs were able to get underway and expand during a period when other efforts to provide large-scale Federal aid to education were blocked by continuing contro-

versies over such questions as support for parochial schools and segregated institutions. That NSF was able to avoid these two blind alleys and to serve all groups of teachers was, staff members feel, an accomplishment of no small magnitude. Viewed from this angle, the very existence of the institutes was and is a significant fact in American education.

From a purely operational standpoint, it appeared in 1965 that the institutes for secondary school teachers could be a lot larger than they then were. While many science and mathematics teachers—one study indicated the figure might be as high as half the eligible population—never applied to institutes, the demand still outstripped supply. Approximately three individuals submitted applications to summer institutes for every stipend offered. NSF staff members also estimated that, on the average, they turned down 100 proposals from colleges and universities each year that would have been worthy of receiving grants to hold summer institutes if NSF had extra funds.

The Foundation admittedly has not been successful on all fronts. For example, the original theory that institutes would result ultimately in an increase in the Nation's pool of scientists and engineers does not appear to be working out as intended. The rewards of science must compete with the attractions of other fields and, while the number of students majoring in college in science and mathematics has increased in absolute terms, available statistics indicate that the percentage has not risen and—according to NSF's own projections—probably will not rise by an appreciable amount during the rest of the century. In other words, those increases that have occurred are due to population expansion.

NSF also apparently had a negative influence on privately sponsored programs for assisting secondary school science and mathematics teachers and it failed to persuade colleges and universities to incorporate special institute courses into their regular curriculums on a scale large enough to permit it to shift more of the burden of retraining teachers over to them. Neither has the example set by the institutes programs rubbed off to the extent that NSF hoped it would on the undergraduate curriculums in colleges and universities preparing students to teach—a failure that strikes right at the heart of NSF's entire effort to improve science education. For unless new teachers who enter the profession each year are well prepared in the subjects they are going to handle, NSF will have to continue indefinitely to devote a large percentage of its institute resources to the job of providing training in basic material that teachers never learned as undergraduates.

The institute concept, nevertheless, does appear to have become embedded in the Nation's educational system. Even if NSF were to

go out of business, it would be impossible to turn the clock all the way back to 1950 and ignore the ideas it has propounded. In the long view of history, it may well be that the greatest contribution of NSF institutes in general, and the summer institutes in particular, is that they helped focus an evolving philosophy of teacher training on a key concept: That subject matter courses should receive essential emphasis. The "workshops" that centered around "how-to" courses have been supplanted by subject-oriented training, such as given in institutes.

NSF institutes may not be the perfect or even the final answer, but they appear to be the best yet devised to achieve large-scale improvements in teaching of science and mathematics in U.S. schools. Furthermore, if by some miracle all the science and mathematics teachers who took jobs each year were well prepared, the task of keeping them abreast with the advancing and widening frontiers of knowledge still would confront, in perpetuity, NSF or whoever was willing to make an investment.

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